

TRANSACTIONS
OF
THE LINNEAN SOCIETY.

I. *Observations on the Natural History and Anatomy of the Pelecanus Aquilus** of Linnæus. By Edward Burton, Esq. F.L.S.

Read February 3, 1818.

THIS bird is most commonly met with by ships crossing the Atlantic ocean, at a great distance from land, and soaring at an immense height in the air; and is known to seamen by the names of Frigate Bird, Man-of-war Bird, Sea Eagle, and Halcyon. An opportunity having occurred to me of collecting several of them at the Island of Ascension, where they are found in vast numbers during the month of September, which appears to be their breeding season, I propose to give some account of their natural history and anatomy; premising, that the specimens which I procured differ essentially in many particulars from the description of the same bird given by Linnæus.

The average dimensions of five were as follows:

Extreme length between the tips of the extended wings, six feet ten inches; length of each extended wing, three feet two inches and a half; length of the largest of the wing-feathers, one

* *Tachypetes aquila* of Vieillot.

foot five inches ; length from the tip of the beak to that of the tail, three feet.

The average weight of the bird with its plumage, is about two pounds twelve ounces ; without plumage, two pounds two ounces.

The predominating colour is black ; but the back of the male is inclined to a glossy-green, similar to that of the common black cock. The plumage of the female is more dusky ; and she differs from the male in having the abdomen and nearly the whole of the head white. The eye and parts immediately surrounding it are black. The beak is of a dirty-yellowish white. The feet of the male are black ; those of the female, of a blueish-white.

The beak is of great strength, and not less than four inches and a half in length ; both the upper and lower mandibles are curved sharply downwards towards the point. Like all the birds of this genus it has a superficial linear fissure on each side of the upper mandible ; and in the mouth are two large longitudinal slits or openings in the palate, near its centre. The tongue is also of the same nature as that of the Pelicans in general, very small and thin, forming an irregular triangle in shape, and its greatest length not more than the third of an inch ; it is situated far back in the mouth, immediately above the opening of the trachea. The neck is considerably longer than that of most other birds of the same genus. The male bird is further distinguished from the female by a large fleshy bag or sac placed under the throat, of a bright-red colour, and in its flaccid state putting on a granulated appearance : when distended it is smooth, and enlarges to the size of a hen's egg. The use of this appendage is somewhat difficult to be understood ; but the fact, that when the bird is at rest the bag is totally flaccid, and when it rises into the air is immediately distended, (which from the heaviness of its flight can be distinctly seen,) renders it most probable that it is then filled with air, and assists in supporting the upper parts of the

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the body in its long and arduous flights. From its situation it is particularly adapted to aid the muscles of the neck in supporting the head, which, from the weight of the beak and bones of the cranium, and the length of the neck, are apparently in want of some such relief. The only fact which interferes with this opinion is the want of this sac in the female, in which it is never found: if, therefore, it be given to the bird for the purposes which have been mentioned, it is to be supposed that only the male makes these prodigious flights, and that the female remains constantly near the land, to which the other returns during the breeding season.

In considering the structure of this bird, its most striking peculiarity consists in the disproportion which exists between the wings and the other extremities; a disproportion so enormous, as probably not to be found in any other, if we except the Ostrich and Cassowary, where it is reversed. It may readily be conceived that the habits of the bird render its immense expanse of wing necessary, as it is frequently seen many hundred miles from any resting-place; but the posterior extremity is so diminutive, in comparison with the size and weight of the body, as apparently to be nearly useless. It is totally inadequate to the process of walking, as when on the ground the bird can be taken by the hand without difficulty; and the structure of the foot, the toes of which are webbed only to their second joint, (which is little more than what is found in land-birds,) together with some other points in its anatomy, prove that it never rests on the water, and is deficient in the great peculiarity of all water-birds, the power of swimming. But as this is perhaps the only one of all the sea-birds which is deprived of that power, it may be proper to examine into the fact before it is assumed.

In the first place, when seizing the food which was thrown to

them on the water, these birds merely skimmed along the surface till they could reach it with the beak, without closing their wings or immersing any part of the body, or sitting on the wave, as all the Pelicans and *Procellariæ* do when feeding. Secondly, the structure of the feet before mentioned prevents them from making any progress in the water, when alighted on it. And, lastly, the gland placed above the tail of all swimming-birds, which secretes the oil necessary for preventing the plumage from becoming wet, in this species is of so trifling a size (being not larger than a garden pea) as to be totally insufficient for that office in so large a bird; in proof of which may be alleged the circumstance of the feathers of those which when shot fell into the sea being entirely wet.

However useless the posterior extremity may be on the water, it is nearly equally so on land; for the bird is unable to run or raise itself into the air from the level ground; and preparatory to its flight is obliged to scramble with its legs and expanded wings to the edge of some rock or uneven surface, where the wing can be put into action so as to hold the air.

As, then, the Frigate-bird is unable to swim on the surface of the water, or to dive into it, and as its food is furnished from that element, we must conclude that it is dependent on its power of darting through the air on its prey, for its preservation and existence. Nature has provided it with a tail, of a particular structure, adapted to this action, and to this organ it is indebted for the precision and velocity with which it is performed. The tail consists of twelve proper tail-feathers, varying in length from seven and a half to sixteen inches, the smallest being placed in the centre, and the longest externally. When closed, it consists of a solid mass of plumage, and when spread, forms a large surface, and is forked like that of a swallow. It is capable of all
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the intermediate degrees of expansion. By spreading or contracting, raising or depressing these feathers, the bird is enabled to throw itself with the greatest velocity towards the surface of the water, and to seize substances on or near it, by the help of its long neck and beak, with the utmost precision, without immersing its body. The mechanism by which this action is performed will be explained when I speak of some of the most important points of its anatomy.

It has also another mode of supplying itself with food. It is seen accompanying flocks of sea-birds, chiefly the *Pelecanus Piscator*: as soon as these have dived after fish, and begin to ascend with their prey in the beak, it attacks them, and seizes what they have taken. Wherever a number of these birds are collected on or near the water, they are invariably accompanied by some Frigate-birds, which hover directly over them, or follow them in their flight. Their food consists almost entirely of fish, and chiefly of the *Exocoetus volitans*, or flying-fish, which are the most accessible to them; though they probably occasionally feed on such of the *Mollusca* as come within their reach; and will also seize pieces of pork, fowl's entrails, or any animal substance thrown to them. A young one, covered with down, without any appearance of feathers, except the primores of the wings, and unable to move, when taken vomited seven flying-fish; and the stomach and intestines of all those opened were full of the bones of small fish.

The female deposits one egg, of a white colour, nearly resembling a hen's egg, though somewhat larger. The male bird sits,—a fact clearly established, as one was absolutely taken by the hand when sitting. At this time the female is employed in searching for food: at least this appears probable, from the circumstance of all the male birds being taken on shore, while the females were shot at sea; besides the great proportion of the latter

ter which were constantly on the wing, as ascertained by the whiteness of the abdomen.

This bird makes no nest; it merely finds out some slight concavity among the rocks, where there is a little sand, on which it lays its egg. The young one after it is hatched is fed on fish brought to it by the parent birds.

ANATOMY.

I shall only dwell on those parts of the anatomical structure of this bird which appear most essentially to differ from that of others of the same Linnæan genus; and this is particularly the case in its osteology. The bones of the head in general are thick and heavy, and the cavity of the *cranium* extremely small in comparison with the size of the head; so much so, that this cavity of one of the genus *Psittacus*, of equal or even of inferior size, contains not less than three times the quantity of brain. The vertebræ of the neck are very numerous, and have great flexibility on each other. The number of the ribs on each side is seven; the upper one is false, or unattached to the sternum; the other six are true. The process given off by the second, third, fourth, fifth, and sixth, is situated about one-fourth of their length from the sternum, and just before the termination of the first division or joint; it is of nearly similar breadth and thickness with the rib itself, of more than half an inch in length, and descends directly towards the next, lapping over its outer side. The inferior rib wants this process. These appendages serve to strengthen the parietes of the chest generally, to enable the ribs better to support the action of the muscles, and particularly to afford a more extensive surface for the attachment of the great pectoral muscles, the size of which accords with the magnitude of the wing. Each rib is divided into three separate portions, or bones, connected to each other and to the sternum by intermediate

intermediate cartilages. Of these the vertebral portion is the largest and strongest, and forms in the lower ribs about one half of the whole. The sternum, clavicles, and particularly the bones of the upper extremities, are of a size and strength out of all proportion with the other parts of the skeleton. The pectoral process of the sternum is very deep, to assist as much as possible in giving an adequate surface of attachment to the pectoral muscles. The relative proportions of the bones of the anterior and posterior extremities are so extraordinary as to merit particular observation; on which account I shall mention some of them.

The length of the Os humeri is	7 $\frac{1}{4}$ inches.
Ulna	9 $\frac{1}{2}$
Radius	9 $\frac{1}{2}$
Os femoris	2
Tibia	2 $\frac{1}{4}$

The length of the os femoris then is to that of the os humeri as one to three and five-eighths; and to that of the ulna or radius as one to four and three-fourths.

The proportions of weight are yet more extraordinary.

The weight of the Os humeri is	175 grains.
Ulna	140
Radius	64
Os femoris	11
Tibia	22

The weight of the os femoris is to that of the os humeri as about one to fourteen; and to that of the ulna as about one to eleven.

The bones of the pelvis are so light as to be in many parts transparent; and further to obviate the effect of weight, there is a double row of foramina running down each side of the os sacrum, which in the fresh state are filled with a thin ligament, to
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which the muscles are attached, serving to lighten these parts still more. The acetabulum is also a large foramen, with the circumference a little raised and thickened; and the head of the os femoris is so irregular, that its motion in the acetabulum must be very limited and imperfect; forming an additional proof how useless this extremity is to the bird.

The structure of the bones of the tail forms one of the most remarkable parts of the skeleton. They are adapted to give support to the great mass of tail-feathers, and form a surface of attachment for the numerous muscles necessary to the various and extensive motions of the tail. They are seven in number, six of which are vertebræ, totally distinct from, and having a great degree of motion in every direction, on each other. A large and strong spinous process arises from every bone nearly perpendicularly, and two long and thick lateral processes, varying in length from half to three quarters of an inch, and connected to each other by lateral ligaments. Every bone, between the spinous process and its body, is perforated for lodging the continuation of the spinal marrow. The upper vertebra is the smallest, the size progressively increasing to the last, which is the largest of the six. The lateral processes of the upper vertebra have a bony union with the pelvis, as well as the inner surface of the body. Each vertebra has small obtuse articulating processes, the inferior being most conspicuous. The two last vertebræ are furnished with additional processes, no appearance of which is to be found in the others: these have a common origin from the inner surface of the body of the bone, immediately become forked, and are turned obliquely towards the vertebra above, over which they lap, serving to give additional attachment to muscles. The structure of the seventh bone is altogether different from any of the preceding: in shape it has some analogy to the vomer of the human cranium, but is less in size, its
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longest dimension being about an inch. Its body is thin and transparent, consisting of two lamellæ; towards the root, where it is attached to the vertebræ, it becomes thicker, and has several perforations; on the lower edge it has two depressions, which receive the spinous processes of the fifth and six vertebræ. This bone intervenes between, and serves to support two fatty masses or cushions, of a firm consistence and having almost a glandular appearance, into which the roots of the great tail-feathers are inserted; these lie on the outer surface of the lateral processes of the vertebræ. To various parts of these masses and to the lateral processes of the vertebræ are attached seven distinct pairs of muscles for regulating the action of the tail, which, as has before been observed, appear to be of vital importance to the bird. The upper and largest pair arises fleshy from the dorsum of the pelvis, and tendinous from the back of the lateral processes of the vertebræ, and is inserted into the fatty masses before mentioned: four pairs of muscles of less size also arise from the lower edge of the pelvis, and from the ends of the upper lateral processes, and have their attachment to the same parts: and two pairs have their origin from the inner surface of the bodies of the vertebræ and the lower edge of the pelvis, and are attached close to the termination of the tail-feathers. It is apparent that the action of these muscles, either separately or in their different combinations, is equal to that variety of action, which it has been one of the objects of this paper to prove to be indispensably necessary to the bird's existence.

The muscles of the upper extremities are large in proportion to the bones. The two great pectoral muscles alone are of so enormous a size as to weigh nearly one-fourth as much as the whole body of the bird.

The liver occupies the greater part of the abdomen, and is divided into two lobes of nearly equal magnitude, of much

greater length than breadth ; they run down through the whole cavity on each side of the spine. The gall-bladder is attached to the inferior surface of the right lobe, is very large, and in the birds dissected was found full of bile, in colour and consistence exactly resembling that found in the human gall-bladder.

The œsophagus, as in all these birds, is extremely capacious, and very little inferior to the stomach in its dimensions ; a structure well adapted to the precarious mode of feeding to which they are subject, as they are sometimes for a long time destitute of food, and at others gorge to such a degree as to fill not only the stomach, but the œsophagus and even the mouth with entire fish, which are left there to be digested at leisure. I have seen one of the *Sulæ*, when taken, so full of flying-fish as to be unable to close its beak. The parietes of the œsophagus are nearly half an inch in thickness, and the longitudinal bands of muscular fibres are very large and distinct through the whole canal. The convolutions of the intestines are not numerous, and soon terminate in the cloacæ.

The volume of the brain, as has before been remarked, is particularly small, considering the largeness of the head and body : indeed the same remark will hold good with regard to the generality of sea-birds.

The sac situated under the throat of the male is composed of a thin carunculous membrane, highly vascular, and in structure precisely similar to the gills of the common cock : when flaccid it is thrown up into rugæ, but when distended it is smooth, and the appearance of follicles is lost. On the inside of this sac is placed a thin muscle, which, arising in the lower part of it, forms a loose expansion towards the centre, and sending off several small tendinous chords, is attached by them to different parts of the superior parietes of the sac, exactly in the same manner as the *chordæ tendineæ* are attached in the ventricles of the

the human heart. The use of this muscle is evidently to diminish the cavity of the sac, and to expel the air which it contains when the bird is on the wing. I could not, however, discover by what aperture the air is admitted into, or expelled from it: no connexion between it and the mouth or trachea could be discovered either by the eye, the probe, or the blow-pipe, though the trachea is distinctly seen running behind it through its whole length. But as it becomes inflated as soon as the bird rises into the air, and remains flaccid while it is on the ground, little doubt can be entertained that it is a receptacle for air, and affords an additional facility to its flight.

In conclusion it may be remarked, that the bird which approaches nearest in its habits and general structure to the Frigate-bird, is the *Phaeton athereus*, or Tropic-bird. Both are seen at immense distances from the land, enveloped in clouds, and scarcely perceptible to the eye. Both seize on their food by darting through the air with inconceivable velocity. Neither, when placed on the level ground, can raise itself into the air. But the great peculiarities of the Frigate-bird are wanting in the Tropic-bird. No air-bag is found under its throat: the lower extremities, though very ill proportioned to the wings, are less so than in the Frigate-bird; and the feet being webbed, it is able to swim, and to feed itself in that position: the plumage is also defended against the action of the water: the structure of the tail is less complicated, and the flight of the bird is chiefly guided by two feathers in it of extraordinary length: nor do the pectoral muscles bear so large a proportion to the size of the body.